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THE CATALASE CONTENT OF LUMINOUS AND NON-LUMINOUS INSECTS COMPARED[1]

ACCORDING to Dubois[2] and others the production of light by luminous organisms is an oxidative process. If this is true then it would seem that oxidation should be correspondingly more intense in luminous insects than in non-luminous insects. It has been shown that the catalase content of the different muscles of animals is proportional to the amount of oxidation in these muscles and that the catalase is increased or decreased under the same conditions under which oxidation is increased or decreased.[3] This and similar evidence would seem to indicate a close relationship between the catalase content of a tissue and the amount of oxidation in that tissue If oxidation is more intense in luminous than in non-luminous insects then the catalase content per unit of weight of luminous insects should be greater than that of non-luminous insects. The object of this investigation was to determine if the catalase content per unit of weight is greater in a luminous insect, such as the firefly (Photinus), than it is in non-luminous insects, such as moths, butterflies, honey-bees and bumble-bees.

Method.—After the insect was weighed it was ground up with sand in a mortar. This ground material was added to 50 c.c. of hydrogen peroxide in a bottle and as the oxygen gas was liberated from the hydrogen peroxide by the catalase it was conducted through a rubber tube into an inverted burette previously filled with water. In this way the amount of oxygen liberated in ten minutes from 50 c.c. of hydrogen peroxide was collected. The volume of oxygen was read off directly from the burette, where it had displaced the water. After this volume had been reduced to standard atmospheric pressure the resulting volume was taken as a measure of the catalase content of the insect. Knowing the weight of the insect, the amount of catalase per 30 milligrammes of material was calculated. The calculation was made on the basis of 30 milligrammes of material, because it was found that three of the fireflies used weighed approximately 30 milligrammes. The hydrogen peroxide was prepared by diluting commercial hydrogen peroxide with an equal volume of distilled water. A full description of the method may be found in a previous publication.

Experiments.—Three fireflies previously ground up in a mortar with sand were introduced into a bottle containing 50 c.c. of hydrogen peroxide and the amount of oxygen liberated in 10 minutes was determined. Ten such determinations were made with an average of 118 c.c. of oxygen per 30 milligrammes of firefly. Similarly a moth ground up in sand was introduced into 50 c.c. of hydrogen peroxide and the amount of oxygen liberated determined. The average amount of oxygen liberated by moths was 8 c.c. of oxygen per 30 milligrammes of material. Determinations were also made using honey-bees, bumble-bees, and butterflies. The amount of oxygen liberated in none of these determinations exceeded 25 c.c. of oxygen per 30 milligrams of material.

Conclusions.—The catalase content of a luminous insect where oxidation is presumably more intense is greater than that of a non-luminous insect where oxidation is less intense.

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[1] From the Physiological Laboratory of the University of Illinois. From experiments carried out at Nela Research Laboratory.

[2] Dubois, "Mécanisme intime de la production de la lumière chez les organismes vivants," *Soc. Linneenne de Lyon, Imprimerie* A. Rey.

[3] Burge, *The American Journal of Physiology*, Vol. XLI., No. 2, August, 1916.

EFFECT OF SMELTER GASES ON INSECTS[1]

IT is often claimed that the waste gases, particularly sulphur dioxide, thrown off during the process of smelting copper, lead and some other ores, have a very decided influence on the number of insects in the vicinity of the smelters. Some believe that few if any

[1] Contribution from the laboratories of the American Smelting and Refining Co., department of agricultural investigations.

insects can live in such regions because of the baneful effect of the gases, others believe that insects are unusually abundant there, particularly in regions where more or less injury has been done to vegetation under conditions that formerly existed in some of the smelters. Bees are thought to be particularly susceptible to these gases and it is often claimed that their numbers are so reduced in smelter regions as to seriously affect the fruit crops because the flowers are not properly fertilized. There is no basis whatever for any such claims or beliefs. For several years I have spent all or part of each summer in studying the insects in regions where smelters are located and, for purposes of comparison, in similar adjacent regions, and in no instance have I been able to detect any differences in the number of insects or in the extent of insect injury, due to the presence of smelter gases.

During the last three years the Department of Agricultural investigations of the American Smelting & Refining Co. has carried on extensive series of experiments to test the effect of sulphur dioxide on various kinds of vegetation. As insects are often covered over by the cabinets when they are placed over the plots of grain or other vegetation for fumigating, I have had many opportunities to watch their behavior when subjected to known quantities of sulphur dioxide.

The cabinets used in these experiments were about six feet square and five feet high and were made of celluloid with a light framework of wood. Through these cabinets a current of air carrying a known quantity of sulphur dioxide was driven by means of electric fans. Every precaution was taken to see that the concentration of the gas was constant in all parts of the cabinet throughout the experiment. The time of fumigation varied from half an hour to two or three hours. In every experiment a check cabinet where conditions were exactly similar, except for the absence of the sulphur dioxide, was used. The following sets of definite experiments and observations were made in 1916.

A number of honey bees were placed in a cabinet where SO_2 was being introduced, the strength being 1 part of SO_2 to 1 million parts of air. During the half hour that they were submitted to the fumigation the bees behaved in the same way as did other bees placed in the check cabinet where no gas was being introduced.

In another experiment bees, butterflies, grasshoppers and mosquitoes were placed in the cabinet where 5 parts of SO_2 to 1 million parts of air was being introduced. The experiment was continued for one hour during which time the insects behaved in a normal way, some of the grasshoppers feeding during much of the time as contentedly as they would have fed outside of the cabinet. When the cabinet was removed the insects flew or hopped away and none showed any ill effects due to the confinement for one hour in this concentration of the gas.

At another time while fumigating some alfalfa plants with a very high percentage of SO_2, 25 parts of the gas to 1 million parts of air, I watched a number of insects that were on the plants in the cabinet. The alfalfa weevils, adults and larvæ, went on with their work undisturbed. Flies, mosquitoes, leafhoppers, grasshoppers and ladybird beetles, behaved in a perfectly normal way and at the end of the hour over which the experiment extended, it could not be seen that the fumigation had had any effect on them.

As the concentration of gas in the last experiment was several times as high as we should ever find in the field even quite near the smelters, it is safe to say that the sulphur dioxide given off by the smelters has no effect whatever on the insects in that region.

It is true that SO_2 generated by burning sulphur in a room or other enclosed spaces is sometimes recommended for killing insects. But this is used at the rate of 2 lbs. of sulphur for every 1,000 cubic ft. of space. At sea level and at 20° C. or 68° F. this would give a concentration of gas equal to 24,009 parts of gas to one million parts of air. Even at this rate with prolonged fumigations the insects are not always all killed!

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